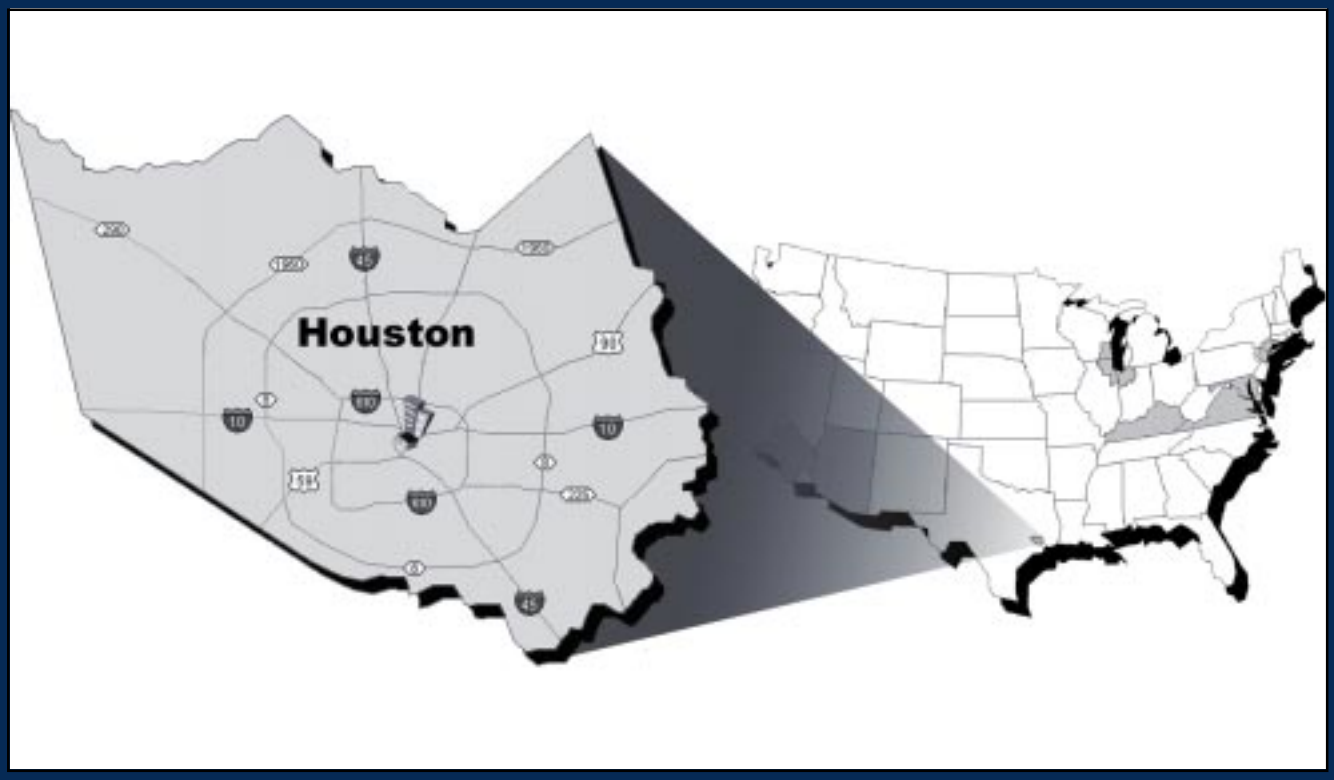
Regional ITS Architecture Development

A Case Study

Houston ITS Priority Corridor



Building a Framework for Regional ITS Integration

September 1999

Foreword

Dear Reader,

We have scanned the country and brought together the collective wisdom and expertise of transportation professionals implementing Intelligent Transportation Systems (ITS) projects across the United States. This information will prove helpful as you set out to plan, design, and deploy ITS in your communities.

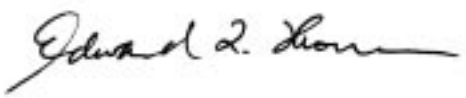
This document is one in a series of products designed to help you provide ITS solutions that meet your local and regional transportation needs. We have developed a variety of formats to communicate with people at various levels within your organization and among your community stakeholders:

- **Benefits Brochures** let experienced community leaders explain in their own words how specific ITS technologies have benefited their areas;
- **Cross-Cutting Studies** examine various ITS approaches that can be taken to meet your community's goals;
- **Case Studies** provide in-depth coverage of specific approaches taken in real-life communities across the United States; and
- **Implementation Guides** serve as "how to" manuals to assist your project staff in the technical details of implementing ITS.

ITS has matured to the point that you don't have to go it alone. We have gained experience and are committed to providing our state and local partners with the knowledge they need to lead their communities into the next century.

The inside back cover contains details on the documents in this series, as well as sources to obtain additional information. We hope you find these documents useful tools for making important transportation infrastructure decisions.

Christine M. Johnson
Program Manager, Operations
Director, ITS Joint Program Office
Federal Highway Administration



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Purpose

This is one of seven studies exploring processes for developing ITS architectures for regional, statewide, or commercial vehicle applications. Four case studies examine metropolitan corridor sites: the New York, New Jersey, and Connecticut region; the Gary-Chicago-Milwaukee Corridor; Southern California; and Houston. The fifth case study details Arizona's process for developing a rural/ statewide ITS architecture. A cross-cutting study highlights the findings and perspectives of the five case studies. The seventh study is a cross-cutting examination of electronic credentialing for commercial vehicle operations in Kentucky, Maryland, and Virginia.

Six of the studies were conducted by U.S. DOT's Volpe National Transportation Systems Center under the sponsorship of U.S. DOT's ITS Joint Program Office, with guidance from the Federal Highway Administration and Federal Transit Administration. The Houston case study was conducted by Mitretek Systems, with support from the Volpe Center.

This study was prepared for a broad-based, non-technical audience. Readership is anticipated to include mid-level managers of transportation planning and operations organizations who have an interest in learning from the experiences of others currently working through ITS architecture development issues.

Case Study Overview

In 1998, Houston transportation stakeholders from the state, county, city, and the transit agency worked together to map Intelligent Transportation Systems (ITS) projects to the National ITS Architecture. Houston was unique among the case studies in using agency staff, rather than consultants, to develop their architectures. This case study describes:

- Laying the groundwork for the development of project architectures during an initial two day meeting;
- Developing architecture mappings for specific projects during a two month-long process;
- The incorporation of architecture mapping into the transit agency's project development process; and
- Questions facing the area in its attempt to take the next step, the development of a regional ITS architecture.

The details of the Houston experience, including samples of architecture mappings and lessons learned are included in this case study, and will be of particular interest for those areas planning to use agency staff to develop ITS architectures.

Background

"Developing an architecture takes time, takes commitment, and the stakeholders must reach agreement on common goals and a common agenda, then stay focused on the goals. The process drew us together. It helped us see ourselves as a team."
— **Rita Brohman, ITS/ Priority Corridor Program Manager, Houston TranStar**

This case study, one of six, describes the specifics of the application of the National ITS Architecture to Houston ITS Priority Corridor projects. Since a regional architecture does not yet exist in the Houston area, Houston Priority Corridor Program projects were mapped directly to the National ITS Architecture. The mapping of projects continued the efforts to promote an integrated approach to ITS in the Houston area.

The information contained in this case study was developed through a review of the Houston ITS Priority Corridor and related literature, as well as a series of interviews with individuals from the key stakeholder agencies involved with ITS projects in the Houston area. The list of those interviewed is included at the end of this report. The findings of this study and the other five case studies will be useful to those public and private sector entities applying the National ITS Architecture to projects in their own regional or statewide programs.

History of Integration in the Houston Area

The first ITS project in the Houston area began in 1963. It was a freeway management project that included ramp metering and automated surveillance. In 1978 Harris County voters created the Harris County Metropolitan Transit Authority (METRO) and approved a local one-cent sales tax to support the construction and operations of a regional transit system. Beginning in the early 1980s, METRO and the Texas Department of Transportation (TxDOT) worked together on High Occupancy Vehicle (HOV) reversible lane projects on five major freeways in the city. METRO's contracting capabilities and the use of state right-of-way brought the two agencies together. Uncharacteristic of a transit agency, METRO is heavily involved in traffic management and capital projects, including HOV lane and road improvement projects. It has a 200-person police force that patrols the transit system, HOV lanes, and freeways.

ITS along the freeway network was managed and operated in the mid-1980s and 1990s by TxDOT. Three satellite Transportation Management Centers (TMC) were connected in the early 1990s. During the 1980s and 1990s, TxDOT and METRO also worked together to implement surveillance and Dynamic Message Signs (DMS) on the freeway and HOV facilities. In the early 1990s, TxDOT, METRO, the City of Houston, and Harris County began plans to build and construct Houston TranStar in order to provide a regional transportation management center for the Houston and Harris County metropolitan area.

Background

Houston ITS Priority Corridor and ITS in the Region

In 1993, U.S. DOT designated the Houston area as one of the four ITS Priority Corridors with dedicated funding authorized by the Intermodal Surface Transportation Efficiency Act. Through fiscal year 1997 (FY97), Houston Priority Corridor Program funding (including state and local agency matching contributions) totaled nearly $22 million.

Demonstration projects under this program provided a significant impetus for ITS in this region. Of the 26 projects initiated through this program, 14 are ongoing and 12 are planned for implementation within the next two years. TxDOT is the lead agency for about half of the projects; METRO has the second largest share. The Houston ITS Priority Corridor program is managed by TxDOT staff at TranStar through the Priority Corridor Technical Committee, and overseen by the TranStar Executive Committee.

TranStar Partners

TxDOT, METRO, Harris County, and the City of Houston formed a partnership in 1993 to guide transportation management and ITS activities in the Houston area. These four agencies, with staff located at the TranStar facility, are responsible for the collection, processing, and dissemination of traffic, transit, and traveler information in the Houston region. The service area encompasses 5,436 square miles and a population of approximately four million people.

TranStar is located in a 52,000 square-foot TMC specially constructed to accommodate the many high-technology components and integrated multi-agency personnel. The Director for Houston TranStar reports to the TranStar Leadership Team, and the TranStar Executive Committee is composed of a representative from each of the four member agencies. Each agency contributes to the annual operating budget of TranStar on a prorated basis relative to its occupancy and utilization of building components. Since the TranStar facility is staffed by the four agencies, each agency's staff is able to work more closely with other agencies in a "team" environment while still reporting to their home agency.

In addition to the four partner agencies in TranStar, the Texas Transportation Institute (TTI) of Texas A&M University has a long history of involvement in ITS in the Houston area. TTI is currently under contract to TxDOT to update the Priority Corridor Program plan. In the past, TTI has supported METRO, City of Houston, and other transportation agencies in the area, as well as the Houston-Galveston Area Council (H-GAC), which is the metropolitan planning organization for the Houston area and surrounding 13 counties.

In 1993, U.S. DOT designated the Houston area one of the four ITS Priority Corridors with dedicated funding authorized in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. Demonstration projects under this program provided a significant impetus for ITS in this region.

Inventory of Components Managed by TranStar include:

- 160-mile Freeway Management System, out of projected 300 miles
- Freeway and Arterial Street Incident Management
- Flow Signals at 115 ramps
- 167 cameras with Closed Circuit Television Surveillance (CCTV)
- Dynamic Message Signs
- 63-mile HOV lane system, (out of the projected 105 miles)
- Regional Traffic Signal System 1,380 signals
- Mass Transit Bus Fleet 1,363 buses
- Emergency Management Operations for evacuations and disasters

ITS Architecture Development

Discussions of the development of regional architectures, especially those contained in high-level overviews, often lack the specifics and details of the development process that are useful to managers faced with developing ITS architectures in their regions. This case study attempts to fill that gap by providing a more detailed look at the process, focusing on the roles of individuals and agencies and the events that took place. It looks more closely than the other case studies at the individual-to-individual exchanges that are part of the process. The timing of the case studies was fortuitous for this approach. Most of those interviewed in Houston had used the National ITS Architecture recently, so many details were fresh in their minds.

Getting Started

In March 1998, U.S. DOT held one of ten National ITS Architecture outreach meetings in the Houston area. The impact of the National ITS Architecture, along with the expected Interim Guidance and eventual rulemaking, became a topic of discussion in the Houston ITS Priority Corridor Program meetings with Federal Highway Administration (FHWA) staff. In particular, Mark Olson, the ITS Specialist from the FHWA Texas Division, identified the potential benefits of applying the National ITS Architecture to the Priority Corridor Program projects. To gain experience with the National ITS Architecture, develop an understanding of its ability to support the integration of ITS projects, and ensure that Houston Priority Corridor Program projects would meet all requirements for continued Federal funding, the TranStar members participating in the Priority Corridor Program agreed on the goal of having an architecture in place for each project expecting to receive FY97 Priority Corridor funds. Architecture mappings would be attached to the Work Orders included in the Priority Corridor Program Quarterly Reports to FHWA. The Priority Corridor Program projects would also serve as pilot projects in Houston to facilitate mapping of future projects to the National ITS Architecture.

As a first step in creating an architecture for each project, potential stakeholders were identified for the 12 Priority Corridor Program projects expecting FY97 funds. Included in the list of stakeholders were:

- FHWA (Region and Division)
- TxDOT (Houston District Information Systems and Traffic Operations Division in Austin)
- METRO (Department of Traffic Management)
- Harris County (Engineering Department and Office of Emergency Management)
- City of Houston (Engineering Department and Office of Emergency Management)

- The metropolitan planning organization
- TTI
- Lockheed-Martin, the TranStar system integrator
- Federal Transit Administration (FTA) Region 6 Office

The level of expertise with the National ITS Architecture among these stakeholders was limited. Some staff had been introduced to it through U.S. DOT sponsored classes or through the outreach meeting in March. However, no one had significant experience applying the National ITS Architecture to local ITS projects.

The Initial Stakeholder Meeting

In May 1998, stakeholders met at the TranStar facility and began working with the National ITS Architecture. The goal of the meeting was to map the 12 Priority Corridor Program projects to the National ITS Architecture. In retrospect, this goal was extremely ambitious. Although the stakeholders did not achieve this goal during the two-day meeting, they did create detailed mappings for three existing projects, gain experience with the language and logic of the National ITS Architecture, establish stakeholder involvement, and set the foundation for mapping the projects.

"Some stakeholders may not think they have an interest, but often those who see themselves as the least likely to benefit from developing an architecture are the ones who, in fact, benefit the most."
— Susan Beaty, Senior Project Manager, Houston TranStar, METRO

The meeting format was informal. An FHWA Headquarters representative acted as the facilitator. During the first day, the stakeholders attempted to develop an architecture for the TranStar system, and then use it as a reference for the development of the individual project architectures. In 1996, an attempt had been made to document the TranStar architecture, but was not completed. This attempt was prior to the release of the National ITS Architecture. Even if it had been completed, significant revisions would have been needed to reflect both the current state of the TranStar system and the details of the National ITS Architecture.

The stakeholders began by identifying the National ITS Architecture subsystems and the stakeholder organizations associated with each subsystem. Since the stakeholders had limited experience with the National ITS Architecture, time was needed for them to become familiar with its details. Progress was slow and, after a few hours, the meeting lost momentum. It was at that time that John Olson, Manager of System Integration at METRO, distributed preliminary architecture mappings he had created for one of the Priority Corridor Program projects. He had gained experience using the National ITS Architecture prior to the meetings by creating project mappings. In retrospect, his mappings reflected physical components rather than National ITS Architecture subsystems, but having a sample map for the stakeholders to consider restored momentum.

ITS Architecture Development

The stakeholders refocused on developing a TranStar architecture and continued until the end of the day, when it became clear that TranStar was too large a system to complete a comprehensive architecture within the two-day meeting.

"For a first project, pick one large enough to have data flowing to or from most of the stakeholders. Using this as an example in an early meeting will bring more people into the process."
— Susan Beaty, Senior Project Manager, Houston TranStar, METRO

At the beginning of the second day, the stakeholders changed their focus to developing an architecture for an existing Priority Corridor project, the *Automatic Vehicle Identification (AVI) System—Phase IV Project*. The AVI Project proved to be a good choice for two reasons. First, it was already in the implementation phase, so differing opinions of what the project *should* be did not bog down the discussion. Second, it was a data source for many other projects, so most of those present at the meeting were stakeholders in its operation. By the end of the second day, a preliminary architecture for the AVI project had been completed. This architecture was then used, in the final minutes of the meeting, as a template for mapping architectures for two additional ITS Priority Corridor Program projects. The stakeholders found that once the AVI project had been mapped, it was relatively easy to add the components of the two additional related projects.

The National ITS Architecture CD-ROM and a projector were available at the meeting, but neither was very effective, given the size of the group and the dimensions of the meeting room. Hard copy handouts of the market packages were effective, allowing each member to page back and forth as needed. The stakeholders used the market packages extensively during the meeting. The actual mapping of the architecture for the AVI project was done on white boards and flip charts.

Architecture Development for Priority Corridor Projects

"We did the mapping with in-house staff; it was better to do it that way than to hire a contractor to do it. If we had hired a contractor, the mapping would have been theirs, without enough ownership from the agencies."
— John Gaynor, Manager, Houston TranStar, TxDOT

After the two-day meeting in May, the real work of mapping the remaining ITS Priority Corridor Program projects to the National ITS Architecture began. Stakeholder agencies identified staff to participate in the development of the architecture. Those active in leading the development effort were Rita Brohman (TxDOT), John Olson and Susan Beaty (METRO), and Wayne Gisler (Harris County). Each of the 12 ITS Priority Corridor Program projects to be mapped was managed by one of these agencies. The City of Houston, a participant in some of the 12 projects, supported the idea of developing an architecture, but staff resources limited their ability to participate. The metropolitan planning organization also supported the idea and reviewed the resulting mappings, but did not participate in their development. TTI provided support for the effort. In particular, Gene Goolsby was active in the development effort. Mark Olson from FHWA continued to provide encouragement and direction, responding to questions and acting as an information resource. These individuals, as well as the other participants, brought varied skills to the process including planning, system engineering, and traffic engineering experience. Significantly, they were all familiar with TranStar and the ITS Priority Corridor Program projects.

ITS Architecture Development

During a two-month period in the summer of 1998, the mapping of the projects accelerated, with participants committing 80 to 100 hours to the effort. During this time, a series of working meetings was held. In general, attendance was limited to staff from the stakeholder agencies who were decision makers or who had access to decision makers in their agencies. Rita Brohman coordinated the meetings and documented the activities of the group.

The Interim Guidance on the National ITS Architecture suggested that for areas without a regional architecture, conformance would be accomplished by defining ITS project(s) using the subsystems and information (architecture) flows from the National ITS Architecture. This was the approach used in Houston. Defining project architectures started with a brainstorming session to decide which market packages applied. In the National ITS Architecture, market packages identify one or more equipment packages that must work together to deliver a given transportation service, along with the architecture flows that connect them to other equipment packages and important external systems. Market package terminology became the common way for the group to discuss the projects.

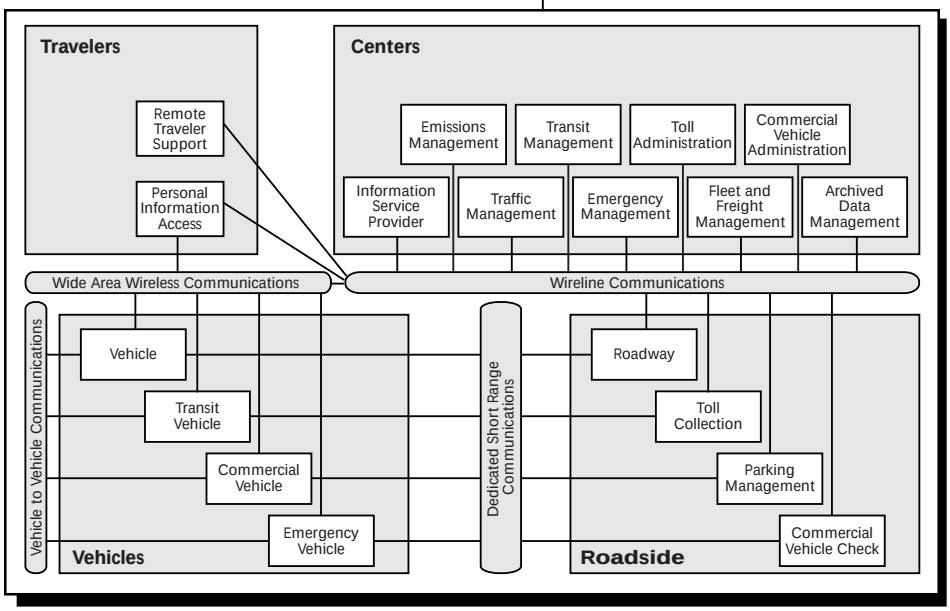
The discussions of the individual projects were led by the project's manager, using the two-or-three page project descriptions from the Work Order. Active participation in the discussion by everyone in the meeting was encouraged. During the discussions, participants learned from each other. Helping to map another manager's project often resulted in a better understanding of a manager's own project. The breadth of comments helped to define the boundaries of the architecture. Prior to these meetings, a Priority Corridor Program project would have only limited involvement from parties beyond the project lead.

"Because each of the participants in developing the project architectures had other responsibilities that couldn't be ignored, it was critical to get all stakeholders to agree to a clear goal and commit to a set time frame for completion. Without these, we might never have seen an end product or understood the value of the architecture."

— Rita Brohman, ITS/Priority Corridor Program Manager, Houston TranStar

Project Architectures

The end product contained four levels of architecture maps for each project. The highest level contained the physical architecture elements. This level was based on the "National ITS Architecture subsystems and communications" diagram from the National ITS Architecture CD-ROM. Usually referred to as the "sausage diagram," it contains the 19 subsystems, four communication systems, and their interconnections.



National ITS Architecture Interconnects

The participants easily completed this level based on their existing knowledge of the projects and their limited experience with the National ITS Architecture. To accomplish a mapping at this high level in a reasonable time, it was necessary to limit the discussion of details and stay focused on the level at hand.

Defining the stakeholders, the next level, was more difficult. All the appropriate stakeholders had to be included. It is critical to get "buy in" from the system "owners." Exactly what defines a stakeholder is difficult to say. The two defining criteria agreed upon in Houston were participation in funding for the project and responsibility for the implementation or the operations of the project.

The third level of mapping, identifying the equipment packages, required the participants to become more knowledgeable about the details of the National ITS Architecture. Projects were discussed in terms of the market packages and the equipment packages contained in them. Equipment packages from multiple market packages were selected and combined in a single drawing, with references to the parent market packages. Once the third level was complete, the data flows among the equipment package were defined in the fourth level. A sample mapping is presented in Appendix A.

In the Trenches at the Meeting

At the beginning of the process, none of the participants felt like an expert with the National ITS Architecture. The initial discussions of the projects made it clear that they were using slightly different terminologies or focusing on different levels of detail. To solve this problem, they agreed to learn the terms and definitions found in the National ITS Architecture, use them, support its process, and follow its logic. As they moved to greater levels of detail, participants were able to identify divergent views of the projects and negotiate solutions, either changing the way the project was described or revising the project itself.

The meetings were held away from the TranStar facility. Moving off-site limited distractions and interruptions. It also limited other agency staff not familiar with the National ITS Architecture from casually participating in the meetings. Without an understanding of the National ITS Architecture's language and logic, their participation would have slowed the group's progress.

Having worked together in TranStar helped the group accomplish a significant amount during a limited time. Working relationships can take longer to establish than people anticipate. The group benefited from having worked together for some time. It allowed more productive discussion and reduced the need for formalities.

"Each agency had a representative at the table who understood the Work Order and the concept of operation for the project. We took each project and walked through the architecture. Having everyone in the room helped each representative become familiar with the others' projects. At the end, participants would say: 'Because we had to map, we got a better understanding of our own project and were able then to take it to a greater level of detail.' "

— Gene Goolsby, Research Engineer, TTI

ITS Architecture Development

Having TranStar as a mature facility with equipment installed and many institutional roles and responsibilities defined also helped the group by underpinning the details of the proposed projects. If TranStar had been a less mature facility, many more of the finer points of the proposed projects would still have been open to discussion. Without the established roles, more negotiations on the specifics of the agencies' roles in the individual projects would have been needed. Both could have increased the time required to accomplish the mappings.

Another key to the success of the effort was the group's commitment to the common goal of ensuring that the ITS Priority Corridor projects would conform to the National ITS Architecture and receive funding. In the minds of the participants, this goal carried with it a real deadline, and that forced progress.

The process was not always easy. Disagreements had to be worked through and resolved. Many pitfalls were recognized. Letting the discussions focus on too much detail or on a specific technology could waste time. ITS standards are complex and prone to differing interpretations; people have strong opinions that could create lengthy discussions. Competition for specific roles in the projects could develop. Unwillingness to compromise, "politics," drawing unreasonable jurisdictional or functional boundaries, or letting the culture or bureaucratic procedures limit progress were all concerns. Flexibility in considering the mapping as "final" was needed; the participants had to recognize that these would be living, evolving documents. The key to successfully overcoming these pitfalls was effective communication. It was critical to ensure that everyone contributed during the meetings, that the agendas of all concerned were on the table, and that the group worked for win-win outcomes.

"While Federal funding was an impetus to proceed through the process and meet the deadline, the major reason for our participation was recognizing that the process is beneficial to our projects."
— Wayne Gisler, Traffic Management and Operations Engineer, Houston TranStar, Harris County

The National ITS Architecture CD-ROM and the National ITS Architecture website were used extensively as reference material during the meeting. These, however, could not simply be applied in a cookbook fashion. The specifics of the ITS projects in the Houston area had to be matched to the details of the National ITS Architecture. For example, emergency management operations have a different function in the TranStar facility than described in the National ITS Architecture. In TranStar, 911 issues are not addressed, but are included in the National ITS Architecture. In contrast, determining hurricane evacuation routes and clearing roads after a natural disaster are part of the responsibilities of Harris County and the City of Houston Office of Emergency Management at TranStar, but these are not included in the National ITS Architecture. If the emergency management functions had been restricted to the National ITS Architecture definition, some of the services that the TranStar facility provides would have been missed. Similarly, the use of automated vehicle identification to monitor trains could not be mapped to the National ITS Architecture, because the architecture does not list a train as

"In the past, one agency would take the lead on a project, so there would be a single focus for design and decision making. With ITS projects that isn't possible. Has the National ITS Architecture proved useful? It has helped identify overlap among projects that resulted in suggested changes incorporated into the project plans."
— John Olson, Manager, Systems Integration, Department of Police and Traffic Management, METRO

a vehicle. In situations such as these, the participants decided to focus on what existed in Houston, modifying what was found in the National ITS Architecture to accurately describe the project. The additions and changes were then noted on their mappings.

Staff time was needed to develop a computer-based design tool to document the mappings. Microsoft® PowerPoint® was selected for two reasons. First, it is a widely used tool with which the project managers and their staff were familiar. They could use it without having a detailed understanding of drafting standards. Second, PowerPoint provided the ability to easily convert the individual maps into presentation slides. A set of standard formats and templates was developed, then used for each project to ensure consistency among the products. The design included use of color for presentations, and black and white for inclusion in reports. These mappings have become part of the Priority Corridor Quarterly Reports to FHWA and are maintained as part of the Priority Corridor Program Manager's duties.

"Working with the National ITS Architecture requires practice. Experience in systems engineering is not enough; that must be supplemented with exposure to the National ITS Architecture."

— Loyd Smith, Director, Planning and Development, Department of Police and Traffic Management, METRO

"We underestimated the persistence needed to get project managers to embrace the architecture and understand it. Most are initially skeptical and see it as a paper exercise that doesn't help their project. These managers are now beginning to realize that they have a better project after going through the process."

— Loyd Smith, Director, Planning and Development, Department of Police and Traffic Management, METRO

Applying the National ITS Architecture at METRO

In addition to participating in the development of architectures for the Priority Corridor Program projects, METRO staff has also been developing architecture mappings for METRO's ITS projects. Loyd Smith, Director of Planning and Development in the Department of Police and Traffic Management, is responsible for the integration function across ITS projects at METRO. Within METRO there are about two dozen engineers working on ITS related projects. This is roughly twice the number of engineers at the TranStar facility. Early in the summer of 1998, Loyd Smith established a two-person team to oversee project integration, led by John Olson. Earlier, in the spring of 1998, METRO had instituted new policies and procedures focusing on the use of the systems approach and a Quality Assurance/Quality Control initiative. Applying the National ITS Architecture was a natural addition to these initiatives. Not surprisingly, the process used to map ITS projects within METRO is similar to the one used to map Priority Corridor Program projects at TranStar. Each project is defined by a work order that includes a project description, schedule, budget, system diagram, and mapping to the National ITS Architecture.

The system diagram presents a more physical representation of the project, while the architecture mapping focuses on the information flows. At METRO, it is taking time for the project managers to become accustomed to this change in perspective and the introduction of new architecture terms and titles. Initially, some project managers did not see the value of the architecture mappings. They prefer to view the projects in terms of functionality that can be bought off-the-shelf, basing their designs on what is available in the marketplace. Another reason managers were reluctant to use the National ITS Architecture, and the systems engineering approach in general, is that mapping and system

engineering is time-intensive and must be done at the beginning of the project. Many managers do not want to make that time commitment so early in the project. Finally, project managers are reluctant to get other stakeholders involved in their projects, believing that with fewer participants, they had a better chance of getting the project finished on time.

METRO staff found that introducing architecture mappings with the information flows made it possible to discover relations that might not otherwise have been seen until later in the project development cycle, ultimately adding to time and cost. Project managers at METRO are now beginning to accept the architecture mappings and see them as more than just a paper exercise.

In mapping METRO projects, John Olson uses the "sausage diagram" to identify the subsystems; he then identifies stakeholders. He has downloaded copies of the market packages from the CD-ROM and uses them to identify the relevant equipment packages and architecture flows. These are documented in a composite drawing using a Computer Aided Design (CAD) tool that overlays the parts of the multiple market packages that apply to the project. The applicable elements from the market packages are included in the mapping; the others have been dropped.

All METRO ITS projects are currently being mapped to the National ITS Architecture, with about 50 percent of the work completed. The goal is to have all ITS projects completely mapped in 1999. The mappings are created and kept by John Olson, rather than the individual project managers.

Architecture Applications and Evolution

"It may not take years for a regional architecture to be developed or to incorporate it into the planning process, but it will take time."

— **Rita Brohman, ITS/ Priority Corridor Program Manager, Houston TranStar**

Regional ITS Architecture

For the region, the TranStar partners have mapped Priority Corridor projects valued at about $22 million. METRO is halfway through mapping $150 million worth of projects. Simply adding them to see what percentage of ITS projects in the region is mapped does not accurately measure the progress toward developing a true regional architecture. The mappings of individual projects do not provide the basis for a visionary use of the National ITS Architecture in the region.

The next step in the Houston area for the development of a regional architecture is addressing a number of questions on the specifics of creating such an architecture. These questions are presented below, along with a short discussion of the issues and options. Many of these, or similar questions, would have to be answered by any region embarking on an effort to develop a regional ITS architecture.

Who would lead the effort? With TranStar composed of four partner agencies, the source of leadership, staffing, and funding sources would have to be agreed upon, as well as the authority of the lead agency. It is one thing to work closely with another agency, but another to let that agency define a common vision. In addition to the TranStar partners, the metropolitan planning organization could also be considered to lead the development. Beyond the region, TxDOT has plans to map ITS projects at the statewide level, but the details are not settled.

What would be the boundaries for the regional ITS architecture? The TxDOT district covers six counties. The metropolitan planning organization covers a greater number of counties, some of which are in different TxDOT districts. The agencies that comprise TranStar cover different areas and the overall area served by TranStar may change with the expected addition of satellite TMCs, for example for I-45 south to Galveston. The issue of geographic boundaries must be pinned down before a regional architecture can be defined.

When will the products of related efforts be available to support the development of a regional ITS architecture? Related efforts include a five year ITS strategic plan by the TranStar partners, updates to the regional ITS plan by the metropolitan planning organization, a short-term strategic plan laying out the TranStar goals and objectives, the definition of user needs for data base warehousing and storage by the TranStar partners, the Priority Corridor Program project and TranStar architectures, architectures for METRO FTA ITS projects (not all of which are at TranStar), and a benefits analysis that TTI is performing for TxDOT. All of these would provide information needed for the development of a regional ITS architecture.

Architecture Applications and Evolution

Who would hold and maintain the regional ITS architecture? Individual agencies currently maintain their own Priority Corridor Program project architectures. The Priority Corridor Program manager also maintains copies. METRO maintains the architectures for its projects outside of the Priority Corridor Program projects. Would a regional architecture be held and maintained centrally? Funding sources for maintaining the regional architecture would have to be identified.

How would the regional ITS architecture be related to the Transportation Improvement Program (TIP) and Statewide Transportation Improvement Program (STIP)? Would it be referenced or incorporated into it? In August 1998, all Priority Corridor Program projects were put into the TIP and by fall they were put into the STIP. However, since these projects were already approved, they did not go through the standard planning process. What would be the procedure in the future? Would projects be subject to certification reviews? Would completed projects be grandfathered or would architectures be needed for them? Answers to these questions could impact the decision-making process on all ITS projects.

"A regional ITS architecture cannot easily be developed within existing staffing and resource levels. Defining the vision and performing trade-off analysis will take a lot of work. A decision on who would do it and who would fund it is needed."

— Loyd Smith, Director, Planning and Development, Department of Police and Traffic Management, METRO

Lessons Learned

"Communication and trust, not technology, is the key. The negotiations must lead to a win-win, or at least a win-neutral result among the agencies. The agreement is only worth what both sides are willing to live with. Will there be long term support for the decisions, through different administrations? We will have to wait and see."

— John Gaynor, Manager, Houston TranStar, TxDOT

Early Steps

- The decision to use the National ITS Architecture must be supported by management, particularly by providing sufficient resources to complete the task. Without a firm deadline and funding at stake, competing needs may have limited the staff and resources made available to develop the project architectures. In Houston's case, the participants in the meetings were motivated to successfully create the architecture mappings.

Agency and Public Education

- ITS projects are different than traditional transportation projects—they cannot be developed in isolation. ITS projects must be integrated. Using the National ITS Architecture encourages consensus-building. It drew the Houston stakeholders together as a team, creating a better understanding of the need for individual project managers to coordinate and work together, as well as the need for overall program management.

- Participants in the development of the project architectures learn by doing. Although the Houston stakeholders had some familiarity with the National ITS Architecture, the individuals reached a comfort level with the National ITS Architecture only after having used it. Only then did participants develop a respect for the process and an understanding of its value.

Stakeholders

- Gathering initial representation from any and all stakeholders in the present system, as well as the future system, is absolutely necessary. In Houston, this furthered the development process in two ways. First, it ensured accuracy and a common understanding of the projects. Even though staffs from the four agencies are co-located at TranStar, there are communication challenges and variations in plans across agencies. Second, it promoted ownership of the resulting architecture, a necessity if the architecture is to influence the system design.

- Identify those stakeholders that should be included in the detailed development work. When in doubt, invite a potential stakeholder to the initial meeting to determine his or her interest and commitment. Later, the number of direct participants must be limited to a working group size in order to allow focused, substantive discussions to occur. These participants must be decision-makers or have access to decision-makers.

- Drawing tools will be needed to document the architectures. Developing drawing tools takes time, but having a common format for all project managers pays off. Either a presentation or a CAD tool could be used; whatever users feel comfortable with.

Lessons Learned

Intergovernmental Cooperation

- Before a regional architecture can be developed, the roles of the different agencies and the architecture boundaries have to be defined. Funding, staffing, and oversight issues need to be discussed and negotiated among the agencies involved.

Available Resources

- Applying the National ITS Architecture requires a dedicated core of individuals representing the stakeholder agencies. In Houston, using the National ITS Architecture was intimidating at first. It required adapting to a new language and a new way of looking at the projects. However, the success could not otherwise have been accomplished, given the changing cast of characters.

- Leadership at the working level is needed. For both the ITS Priority Corridor Program projects and the METRO projects, the leaders in the effort to develop the architectures were

  - Credible and capable
  - Able to devote a significant amount of time to the effort
  - Experienced with the agencies involved
  - Sufficiently experienced with the technical aspects to avoid unrealistic solutions
  - Willing to become knowledgeable about the National ITS Architecture and systems engineering

- Consultants can be useful, but agency staff must be directly involved in developing project architectures. In Houston, consultants were not used to develop the project architectures, and the participants agreed that having stakeholder staff develop the architectures was the correct approach to begin with. A consultant cannot determine who the stakeholders are or resolve the issues surrounding inter-agency roles and responsibilities.

- Consultants are expected to play a significant role in the development of a regional architecture. It was suggested by some Houston participants that a consultant would be very useful after the identification of stakeholders, agency responsibilities, and interfaces by agency staff. Once these are defined, a consultant would be valuable in documenting and developing the details. At the end of the process, though, the agency staff must again get involved to implement the multi-agency coordination identified in the detailed documentation.

"People are more cognizant now that their individual projects need to coordinate and work together. Projects can't be isolated. The National ITS Architecture helps raise awareness of the need to integrate."

— Gilmer Gaston, Agency Manager, Houston TranStar, City of Houston

Lessons Learned

"My suggestion to other areas is just do it. Architecture is a daunting concept. You have to sit down with the CD-ROM and use it in order to learn what it is and what it can do for you."

— Mark Olson, ITS Specialist, Texas Division, FHWA

Institutional Considerations

- Expect initial reluctance on the part of transportation engineers and project managers to embrace the National ITS Architecture. In Houston, some project managers were skeptical of the National ITS Architecture process, often viewing it as only a paper exercise. Transportation and civil engineers were comfortable discussing projects in terms of the physical equipment. Applying the National ITS Architecture was a different approach with a new language.

- Applying the National ITS Architecture makes project managers think through the projects earlier than they otherwise might. The architecture forced Houston's project managers to look at information flows, include more detail in the project descriptions, and tie down the details, limiting the possibility of unilateral, arbitrary changes in the future.

- The National ITS Architecture is not sufficient to ensure that a system will be non-proprietary. Standards are also needed. In the ITS projects in Houston, National Transportation Communications for ITS Protocol (NTCIP) and Transit Communications Interface Protocol (TCIP) are the standards of most concern. Architecture mappings did not reach this level of detail.

References and Additional Resources

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References and Additional Resources

Individuals Interviewed

The authors wish to thank the following individuals, who were interviewed and/or provided other support in the preparation of this case study:

TxDOT:
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Loyd Smith, Director, Planning and Development, Department of Police and Traffic Management

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Gilmer Gaston, Agency Manager, Houston TranStar

Harris County:
Wayne Gisler, Traffic Management & Operations Engineer, Houston TranStar

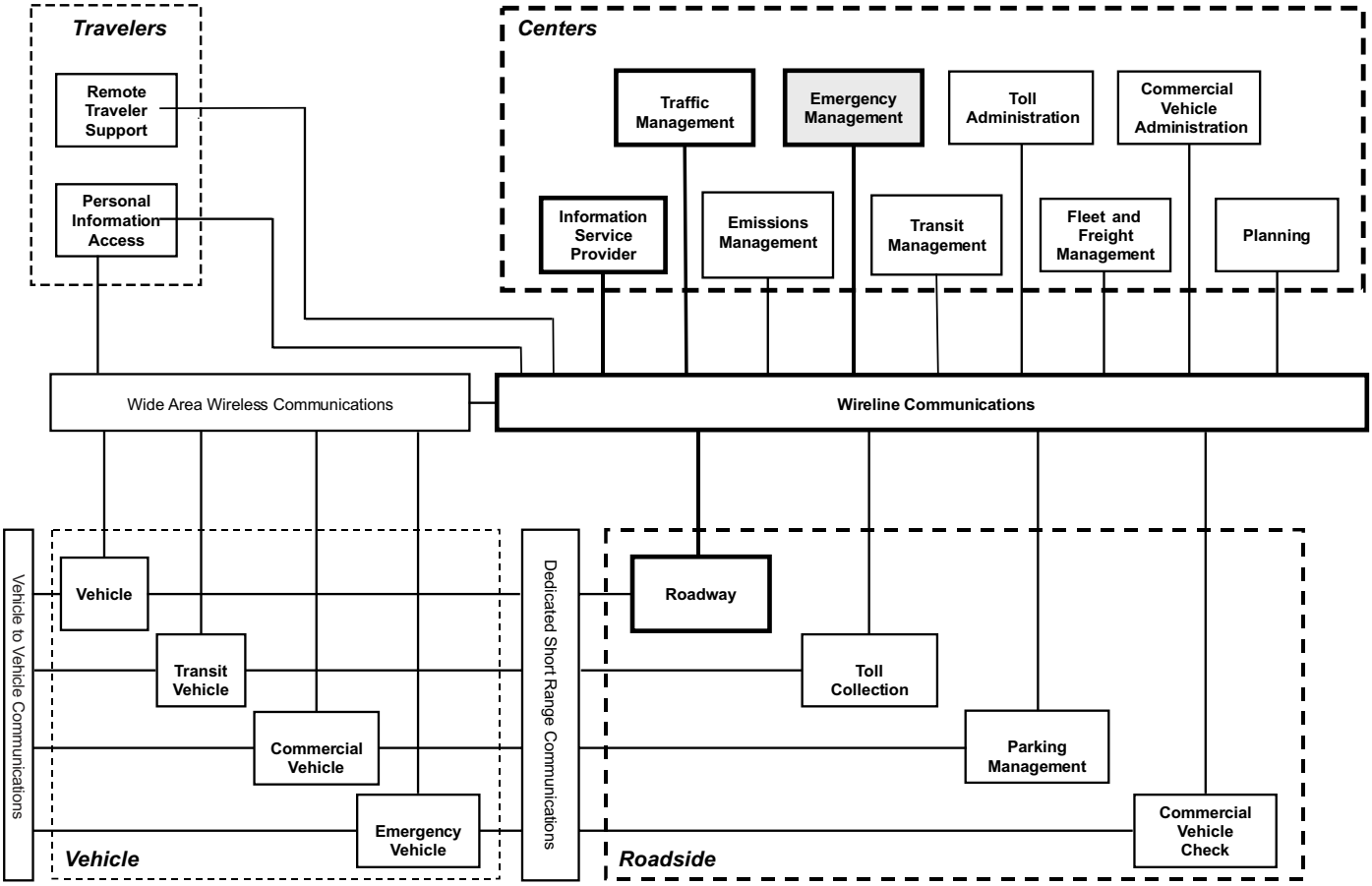
Houston-Galveston Area Council:
Jerry Bobo, Program Manager
Tung-Lung Cheng, Transportation Engineer

Texas Transportation Institute (TTI):
Merrell "Gene" Goolsby, Research Engineer

FHWA:
Mark Olson, ITS Specialist, Texas Division

Appendix A—Project Architecture Mappings

NATIONAL ITS SYSTEM ARCHITECTURE ELEMENTS

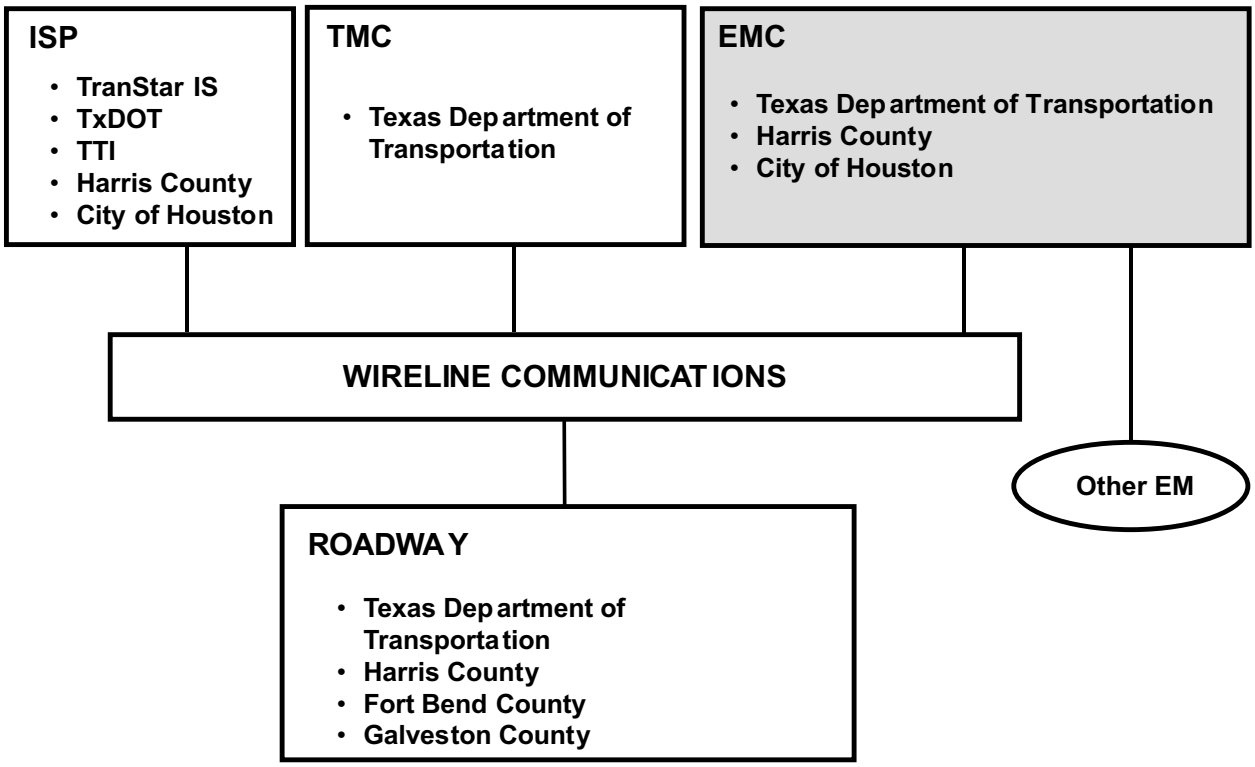


Priority Corridor W.O. #15: Traffic Management & Traveler Information

Lead Agency: Texas Department of Transportation

Appendix A—Project Architecture Mappings

STAKEHOLDERS



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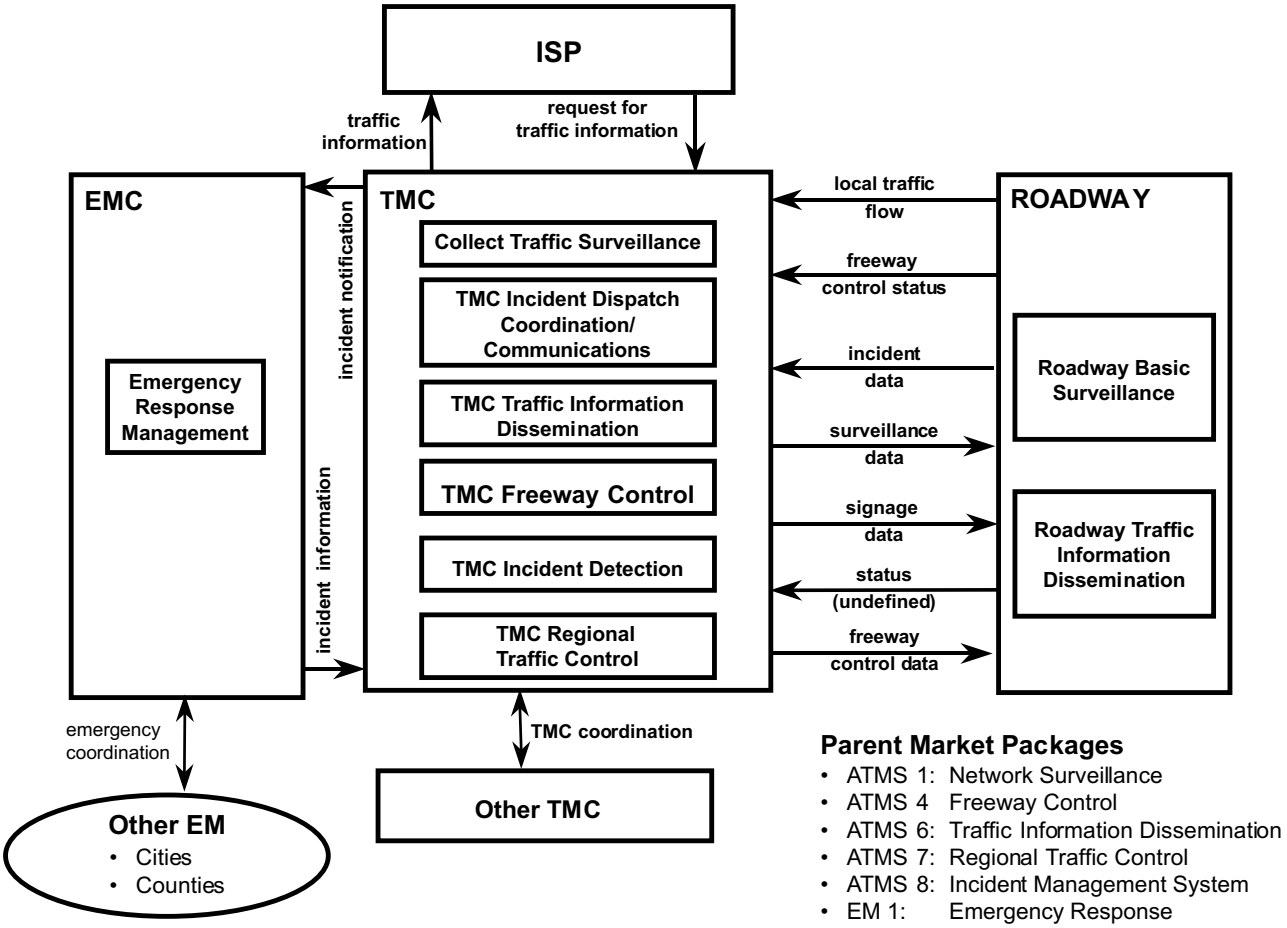
Appendix A—Project Architecture Mappings

IDENTIFICATION OF EQUIPMENT PACKAGES



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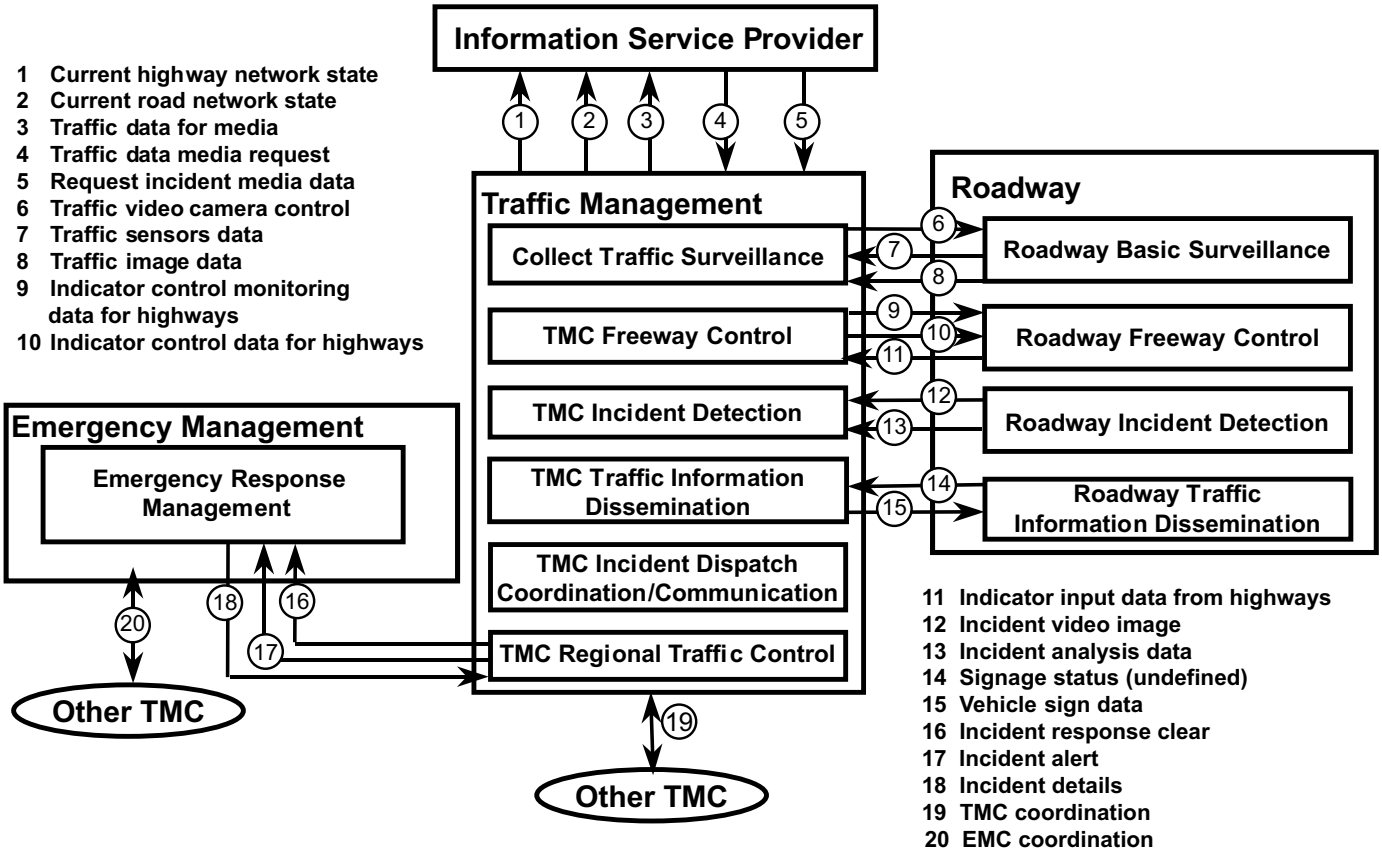
Appendix A—Project Architecture Mappings

IDENTIFICATION OF DATA FLOWS



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